INTEGRATED TYPE PROBE CARD AND ITS FABRICATION METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a probe card or electrical contactor assembly and more particularly, to an integrated type probe card. The invention relates also to the fabrication of the integrated type probe card.

2. Description of the Related Art

Various probe cards or electrical contactor assemblies are seen in US Patent Nos. 4027935; 4754256; 5090118; 5475318; 6072190. These probe cards or electrical contactor assemblies are different in structural design, principle of action and method of fabrication, however they commonly have numerous drawbacks. Regular probe cards include cantilever type, for example, epoxy ring probe cards, and vertical type, for example, cobra probe cards. These two types require much labor to install probes (tungsten contact pins, lead contact pins, or steel contact pins) in the circuit board individually and to adjust the heights of the probes. Because of much human labor is used during fabrication, much fabrication time is required and unequal level status of the probes may affect test stability. Because each probe has a big part exposed to the outside without insulation, parasitic capacitance and induction may produce, resulting in attenuation of high frequency test signal and increase of crosstalk. If the surface of the circuit board under test is not in level, low deformability of probes cannot keep all probes in effective contact with the test points.

Further, there is a limitation to probe installation density by labor. The minimum pitch is about 50μm for cantilever type, or about 100μm for vertical type.

High pin counts results in high manufacturing cost. This pin count limitation imparts a barrier to the development of electronic elements.

Further, in US2002/0080588A1, the spring members used for transmitting test signal from the probes to the circuit board are coiled metal wires. The gap between each two adjacent spring members is insufficient to eliminate crosstalk, and signal error may be produced. Crosstalk may cause an inaccurate test result.

SUMMARY OF THE INVENTION

The present invention has been accomplished under the circumstances in view. It is one object of the present invention to provide an integrated type probe card, which has the probes integrated, reducing the manufacturing cost. It is another object of the present invention to provide an integrated type probe card, which enables the level status of the probes to be conveniently adjustable. It is still another object of the present invention to provide an integrated type probe card, which eliminates the production of noises during signal transmission.

To achieve these and other objects of the present invention, the integrated type probe card comprises a plurality of probes; a circuit space converter, the circuit space converter comprising multiple layers of circuits therein, and a plurality of first contacts and second contacts respectively arranged at two opposite sides of the multiple layers of circuits and electrically connected to the circuits, the density of the first contacts being higher than the second contacts, the first contacts being respectively connected to the probes for transmitting signal from the probes to the second contacts; a spring connector plate, the spring connector plate comprising a holder plate, the holder plate having a predetermined number of receiving holes extended through top and bottom sides thereof, and a plurality of metal spring members respectively mounted in the receiving holes of the holder plate, the metal

spring members each having two distal ends respectively protruded over the top and bottom sides of the holder plate and having one of the respective two distal ends respectively electrically connected to the second contacts of the circuit space converter; a circuit board pressed on one of the two distal ends of each of the metal spring members against the second contacts of the circuit space converter, the circuit board having a plurality of circuits and contacts arranged on one side thereof and electrically connected to the metal spring members of the spring connector plate for testing electric signal transmitted from the probes; and a level adjustment mechanism adapted to hold the probes, the circuit space converter, the spring connector plate and the circuit board in order and to adjust the level status of the circuit space converter, for enabling the metal spring members to compensate elevational difference between the circuit space converter and the spring connector plate and to keep the circuit space converter electrically connected to the circuit board.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic drawing showing the formation of probes for integrated type probe card according to the present invention (I).

FIG. 2 is a schematic drawing showing the formation of probes for integrated type probe card according to the present invention (II).

FIG. 3 is a schematic drawing showing the formation of probes for integrated type probe card according to the present invention (III).

FIG. 4 is a schematic drawing showing the formation of probes for integrated type probe card according to the present invention (IV).

FIG. 5 is a schematic drawing showing the formation of probes for integrated type probe card according to the present invention (V).

FIG. 6 is a schematic drawing showing the bonding between the probes and

the probe holders according to the present invention (I).

FIG. 7 is a schematic drawing showing the bonding between the probes and the probe holders according to the present invention (II).

FIG. 8 is a schematic drawing showing the bonding between the probes and the probe holders according to the present invention (III).

FIG. 9 is a schematic assembly view of an integrated type probe card according to the present invention.

FIG. 10 is a partial view showing an alternate form of the spring members used in the spring connector plate according to the present invention.

FIG. 11 is an exploded view of the integrated type probe card according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1~11, an integrated type probe card **100** is shown comprised of a predetermined number of probes or contacts **10**, a circuit space converter **20**, a spring connector plate **30**, a circuit board **40**, and a level adjustment mechanism **50**.

The probes **10** are made subject to the following Steps I~IV:

Step I: Material preparation. As shown in FIG. 1, a strip-like substrate, for example, a silicon wafer **11** is prepared and pre-treated with washing, drying, and other requisite pre-treatment processes (FIG. 1 is a side view in section of the silicon wafer).

Step II: Substrate etching. As shown in FIG. 2, LIGA (Lithography process) is employed to precisely define the geometrical shape and locations of probe tips, and then anisotropic etching is employed to etch the silicon wafer **11** to a predetermined depth by means of RIE (Reactive Ion Etching) so as to form elongated cantilever spaces **12** of high aspect ratio, and then anisotropic etching is repeated to etch one end

of each elongated cantilever space **12** to a predetermined depth by means of RIE (etching depth over the bottom of each cantilever space **12**) so as to form probe head spaces **13**, and then the etched substrate is dipped in a silicon etching solution, for example, KOH (potassium hydroxide) to have an etched space **14** shaped like an inverted quadrilateral pyramid be formed in the bottom side of each probe head space **13**, keeping the bottom side of each etched space **14** at the same depth. Alternatively, this etching step can be done by: forming the etched space by means of the application of the silicon etching solution, and then employing RIE to make the cantilever spaces and the probe head spaces. Because the aforesaid RIE and anisotropic etching are known techniques, no further detailed description in this regard is necessary.

Step III: Seed layer formation. As shown in FIG. 4, sputtering technique is employed to form a seed layer **15** in the probe head spaces **13**, etched spaces **14** and cantilever spaces **12**. The material used in sputtering is an electrically conductive material, for example, copper, nickel, titanium, or any suitable metal. Instead of sputtering, the seed layer **15** can be made by means of evaporation, deposition, or any suitable processing process.

Step IV: Electro-forming of probe heads and cantilevers. As shown in FIG. 5, micro electro-forming technique is employed to make probe heads **16** and cantilevers **17** in the probe head spaces **13** and etched spaces **14** and the cantilever spaces **12**. The metal used in micro electro-forming is Ni-Co (nickel cobalt alloy) for the advantages of good conductivity and mechanical properties.

The circuit space converter **20** comprises a multiplayer ceramic substrate (MLC) **21**, which has multiple layers of circuits arranged therein and contacts disposed at the top and bottom sides at predetermined locations and respectively electrically connected to the circuits. Subject to the arrangement of the multiple layers of circuits,

the density of the contacts at the top side is higher than the contacts at the bottom side.

The probes **10** and the circuit space converter **20** are bonded together subject to the following Steps I~III:

Step I: Formation of probe holders **22** on the top of the MLC **21**. As shown in FIG. 6, probe holders **22** are formed of high hardness, for example, Ni-Co on the topside of the MLC **21** at the respective circuit contacts by means of LIGA (Lithography process), and then a bonding layer **23** in formed of tin lead alloy on the probe holders **22** by means of electroplating for the bonding of the probes **10**.

Step II: Bonding of probes **10** and circuit space converter **20**. As shown in FIG. 7, the top side of the free end of each of the prepared probes **10** is respectively bonded to the bonding layer **23** at each probe holder **22** by means of a bonding procedure.

Step III: Probe exposing. As shown in FIG. 8, conventional plasma etching technique is employed to etch the substrate (silicon wafer) **11** under the presence of a low-pressure status gas and an applied voltage (so as to remove the substrate **11** and the seed layer **15**), leaving the metal cantilever type probes **10** exposed to the outside.

The spring connector plate **30** is comprised of a holder plate **31** and a plurality of spring members **32**. The holder plate **31** is made from electrically insulative material, forming an insulative substrate. The holder plate **31** has a predetermined number of receiving holes **33** extended through the top and bottom sides. The spring members **32** are electrically conductive members, for example, pogo pins as shown in FIG. 9, or spring pins **32'** (see FIG. 10) made by means of LIGA. The spring members **32** are respectively mounted in the receiving holes **33** with the respective two distal ends respectively protruded over the top and bottom sides of the holder plate **31**.

The circuit board **40** is a printed circuit board made subject to probe signal,

having circuits and contacts arranged on one side thereof and a plurality of through holes extended through the top and bottom sides at predetermined locations.

The level adjustment mechanism **50**, as shown in FIGS. 9 and 10, is adapted to adjust the level of the probes **10**, comprising a holding down plate **51**, a back plate **52**, an adjustment plate **53**, a front locating plate **54**, and a plurality of differential adjustment devices **55**.

The holding down plate **51** is a spring plate having a center test space **56** cut through the top and bottom side, and four protruding press portions **57** spaced around the center test space **56**. The front locating plate **54** has a center receiving open chamber **58** corresponding to the center test space **56** of the holding down plate **51** in size and contour, and a recessed positioning portion **59** of a predetermined depth formed in one side around the center receiving open chamber **58** corresponding to the contour of the circuit space converter **20**. The back plate **52** and the adjustment plate **53** have the respective center area opened. The differential adjustment devices **55** are comprised of three sets of differential screws **551** and round balls **552**.

Further, a multiplayer PC board may be used to substitute for the aforesaid multiplayer ceramic substrate for electric connection between the probes and the circuit board. The multiplayer PC board has arranged therein multiple layers of circuits and contacts arranged on the top and bottom sides at different density and respectively electrically connected to the multiple layers of circuits.

After understanding of the component parts of the integrated type probe card **100**, the assembly process and features of the integrated type probe card **100** are described hereinafter.

At first, fastening devices **61** are used to precisely fasten the back plate **52** and the adjustment plate **53** in a stack, and then fastening devices **62** are used to fasten

the circuit board **40** and the front locating plate **54** to the back plate **52**, keeping the circuit board **40** sandwiched in between the front locating plate **54** and the back plate **52**, and then the spring connector plate **30** is put in the center receiving open chamber **58** of the front locating plate **54**, keeping one end of each of the spring members **32** respectively pressed on the respective contacts at the printed circuits of the circuit board **40**, and then the circuit space converter **20** is put in the recessed positioning portion **59** of the front locating plate **54** with the side which is connected to the probes **10** exposed to the outside and the other side pressed on the other end of each of the spring members **32** to force the spring members **32** against the circuit board **40**, and then fastening devices **63** are used to fasten the holding down plate **51** to the front locating plate **54**, keeping the protruding press portions **57** pressed on the periphery of the circuit space converter **20** to hold the circuit space converter **20** in the recessed positioning portion **59** of the front locating plate **54** and to let the probes **10** protrude over the test space **56** of the holding down plate **51**, and then the round balls **552** of the differential adjustment devices **55** are put in the front locating plate **54**, and then the differential screws **551** are fastened to the adjustment plate **53** and inserted through the back plate **52** and the circuit board **40** into the front locating plate **54** to press the round balls **552** against the circuit space converter **20**.

During test, the probes **10** transmit test sample signal to the circuits of the multiplayer ceramic substrate (MLC) **21** of the circuit space converter **20**, which transmits signal from the signal contacts of high density at one side thereof to the signal contacts of low density at the other side thereof, for enabling signal to be further transmitted through the spring members **32** of the spring connector plate **30** to the circuit board **40**, achieving the test.

If the probes **10** are not level, turn the differential screws **551** forwards or

backwards to force the round balls **552** to adjust the level status of the circuit space converter **20** (because three points form a plane, the three differential adjustment devices **55** are sufficient to adjust the level status of the circuit space converter **20**), keeping the probes **10** in horizontal. Further, because the spring members **32** of the spring connector plate **30** are used for electric connection between the circuit space converter **20** and the circuit board **40**, the spring power of the spring members **32** compensates elevational change during level adjustment of the probes **10** by the differential adjustment devices **5**, keeping the circuit space converter **20** and the circuit board **40** electrically connected.

Further, because the invention uses openings in electrically insulative plate members to receive the spring members, preventing production of noises and improving test precision of the probe card.

A prototype of integrated type probe card has been constructed with the features of FIGS. 1~11. The integrated type probe card functions smoothly to provide all of the features discussed earlier.

Although a particular embodiment of the invention has been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.